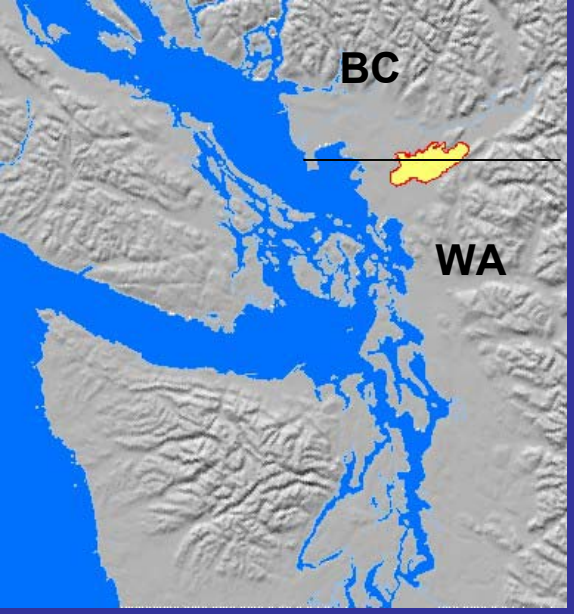

Geology Architecture Mapping of the Abbotsford-Sumas Aquifer

Jacek Scibek (presenting), Aparna Desphande, Diana M. Allen, Nadine Schuurman, and Basil Hii

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Jacek Scibek

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Simon Fraser University, Burnaby, BC

Dr. Nadine Shuurman
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Basil Hii

Environment Canada

OUTLINE:

1. Study objectives
2. Abbotsford-Sumas aquifer
3. Litholog sources and standardization process
4. Unique challenges in acquiring and integrating Canadian and US datasets
5. Progress in development of architecture of the Abbotsford-Sumas aquifer

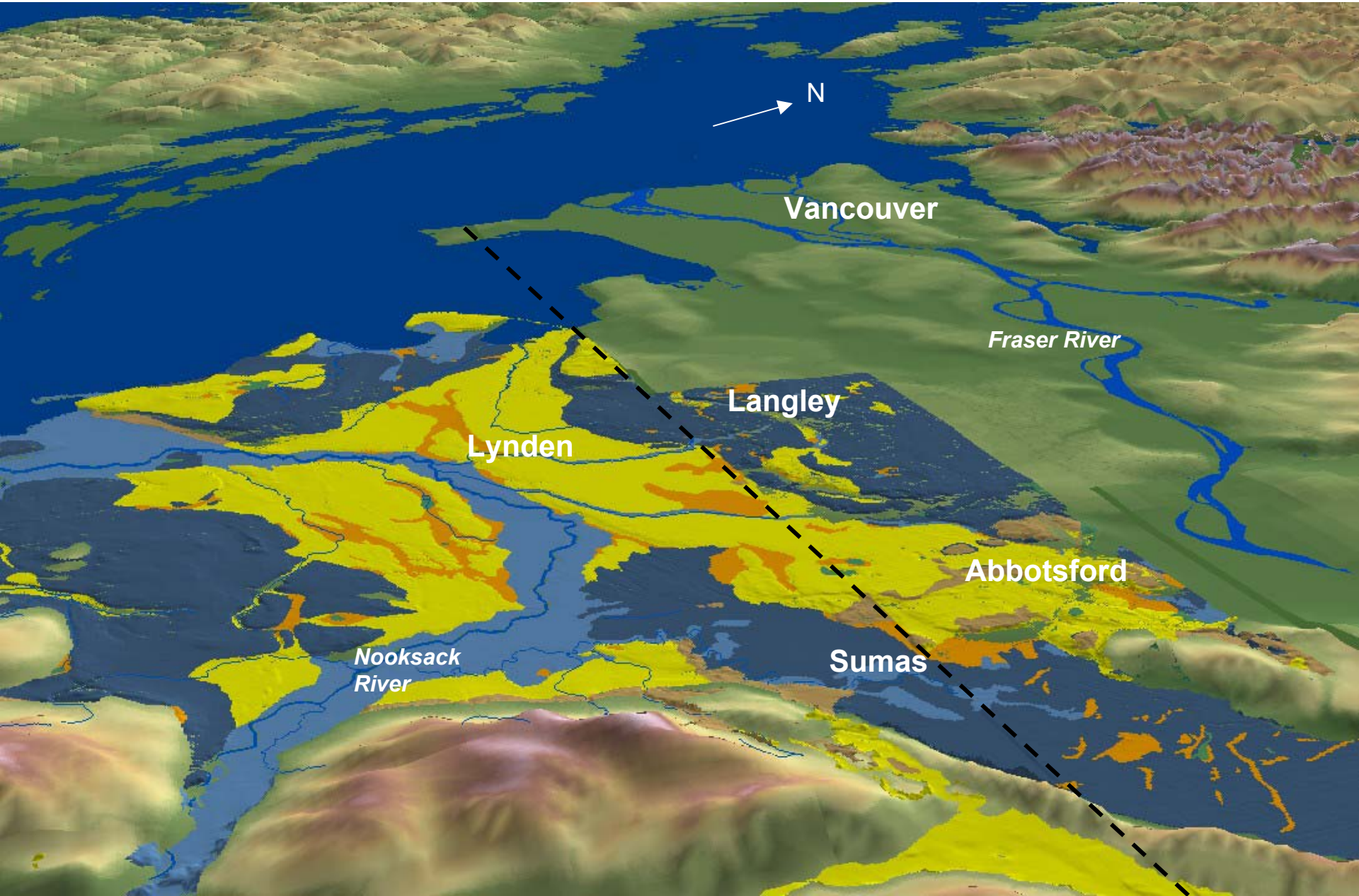
OBJECTIVES:

- mapping aquifer architecture (Abbotsford-Sumas aquifer)
- generate layers for numerical models (flow and transport)
- make best use of limited & low quality data
- standardize & integrate US and Canadian data
- ongoing research at Simon Fraser University and Environment Canada

MODEL APPLICATIONS:

- regional transport model (contaminants)
- local smaller-scale models
- predict effects of land use scenarios on groundwater quality & quantity
- climate change impact scenarios (water resources)

Fraser Valley and Abbotsford-Sumas Aquifer: Surficial Geology



LITHOLOG SOURCES:

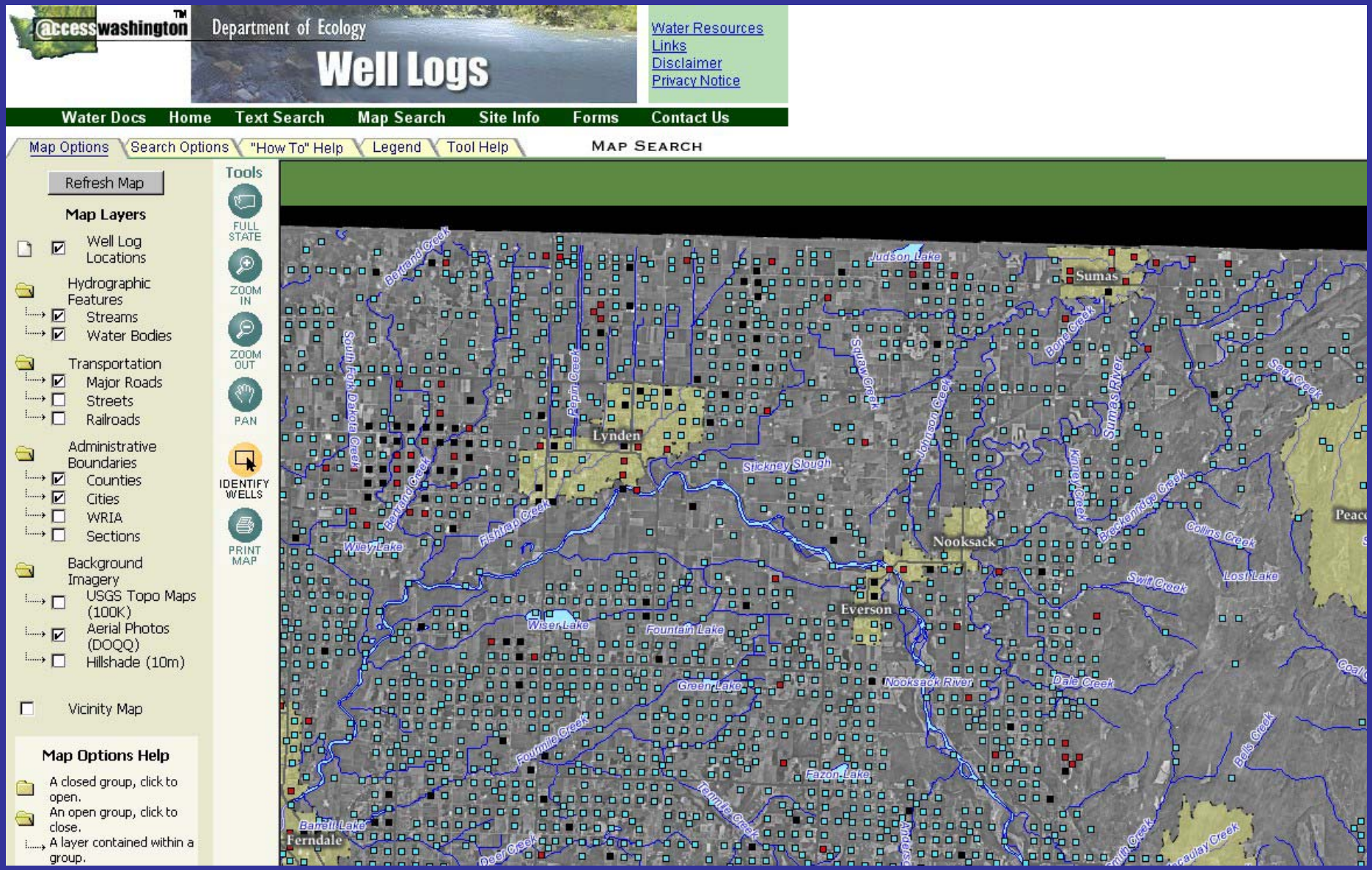
Washington State

- Dept of Ecology (WRIA 1 database)
- NWIFC (Northwest Indian Fisheries Commission)

British Columbia

- BC Ministry of Water Land and Air Protection
- BC Ministry of Energy and Mines (deep boreholes)
- Geological Survey of Canada Papers
- BC Ministry of Transportation (bridge construction sites)

- Drill Core logs – various projects


@accesswashington
Department of Ecology
Well Logs
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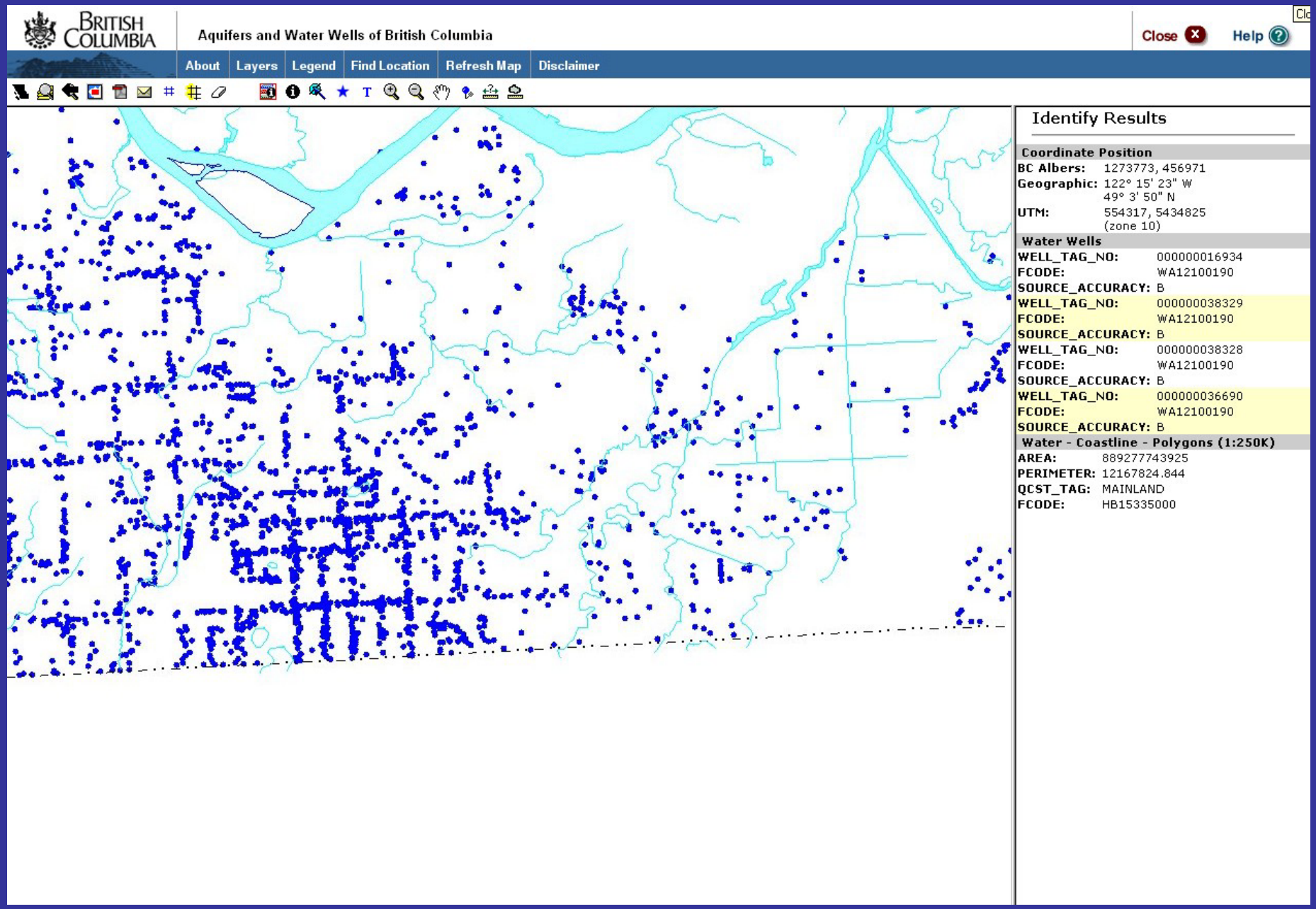
Water Docs
Home
Text Search
Map Search
Site Info
Forms
Contact Us
Map Options
Search Options
"How To" Help
Legend
Tool Help
MAP SEARCH
Refresh Map
Map Layers
Well Log Locations
Hydrographic Features
Streams
Water Bodies
Transportation
Major Roads
Streets
Railroads
Administrative Boundaries
Counties
Cities
WRIA
Sections
Background Imagery
USGS Topo Maps (100K)
Aerial Photos (DOQQ)
Hillshade (10m)
Vicinity Map
Map Options Help
A closed group, click to open.
An open group, click to close.
A layer contained within a group.
Tools
FULL STATE
ZOOM IN
ZOOM OUT
PAN
IDENTIFY WELLS
PRINT MAP
Lynden
Nooksack
Everson
Sumas
Ferndale
Judson Lake
Stickney Slough
Wiser Lake
Fountain Lake
Green Lake
Wiley Lake
Fazon Lake
Nooksack River
Bertrand Creek
Fishtrap Creek
Johnson Creek
Squalicum Creek
Swift Creek
Lost Lake
Collins Creek
Dale Creek
Bells Creek
Tenmile Creek
Fourmile Creek
Deer Creek
Barrett Lake


BRITISH COLUMBIA
Aquifers and Water Wells of British Columbia
Close
Help
About
Layers
Legend
Find Location
Refresh Map
Disclaimer
Identify Results
Coordinate Position
BC Albers: 1273773, 456971
Geographic: 122° 15' 23" W
49° 3' 50" N
UTM: 554317, 5434825
(zone 10)
Water Wells
WELL_TAG_NO: 000000016934
FCODE: WA12100190
SOURCE_ACCURACY: B
WELL_TAG_NO: 000000038329
FCODE: WA12100190
SOURCE_ACCURACY: B
WELL_TAG_NO: 000000038328
FCODE: WA12100190
SOURCE_ACCURACY: B
WELL_TAG_NO: 000000036690
FCODE: WA12100190
SOURCE_ACCURACY: B
Water - Coastline - Polygons (1:250K)
AREA: 889277743925
PERIMETER: 12167824.844
QCST_TAG: MAINLAND
FCODE: HB15335000

How to convert raw lithology data ...

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Application No. .....
Permit No. .....

(1) **OWNER:** Name ..... Address ..... Sumas, WA.

(2) **LOCATION OF WELL:** County Whatcom — SE¼ SW¼ Sec. 4 W.M.

Bearing and distance from section or subdivision corner

(3) **PROPOSED USE:** Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(4) **TYPE OF WORK:** Owner's number of well (if more than one) .....
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☒ Jetted ☐

(5) **DIMENSIONS:** Diameter of well 6 inches.
Drilled 100 ft. Depth of completed well. 63 ft.

(6) **CONSTRUCTION DETAILS:**

Casing installed: 6 " Diam. from +2 ft. to 53 ft.
Threaded ☐ ..... " Diam. from ..... ft. to ..... ft.
Welded ☒ ..... " Diam. from ..... ft. to ..... ft.

Perforations: Yes ☐ No ☒
Type of perforator used .....
SIZE of perforations ..... in. by ..... in.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.
..... perforations from ..... ft. to ..... ft.

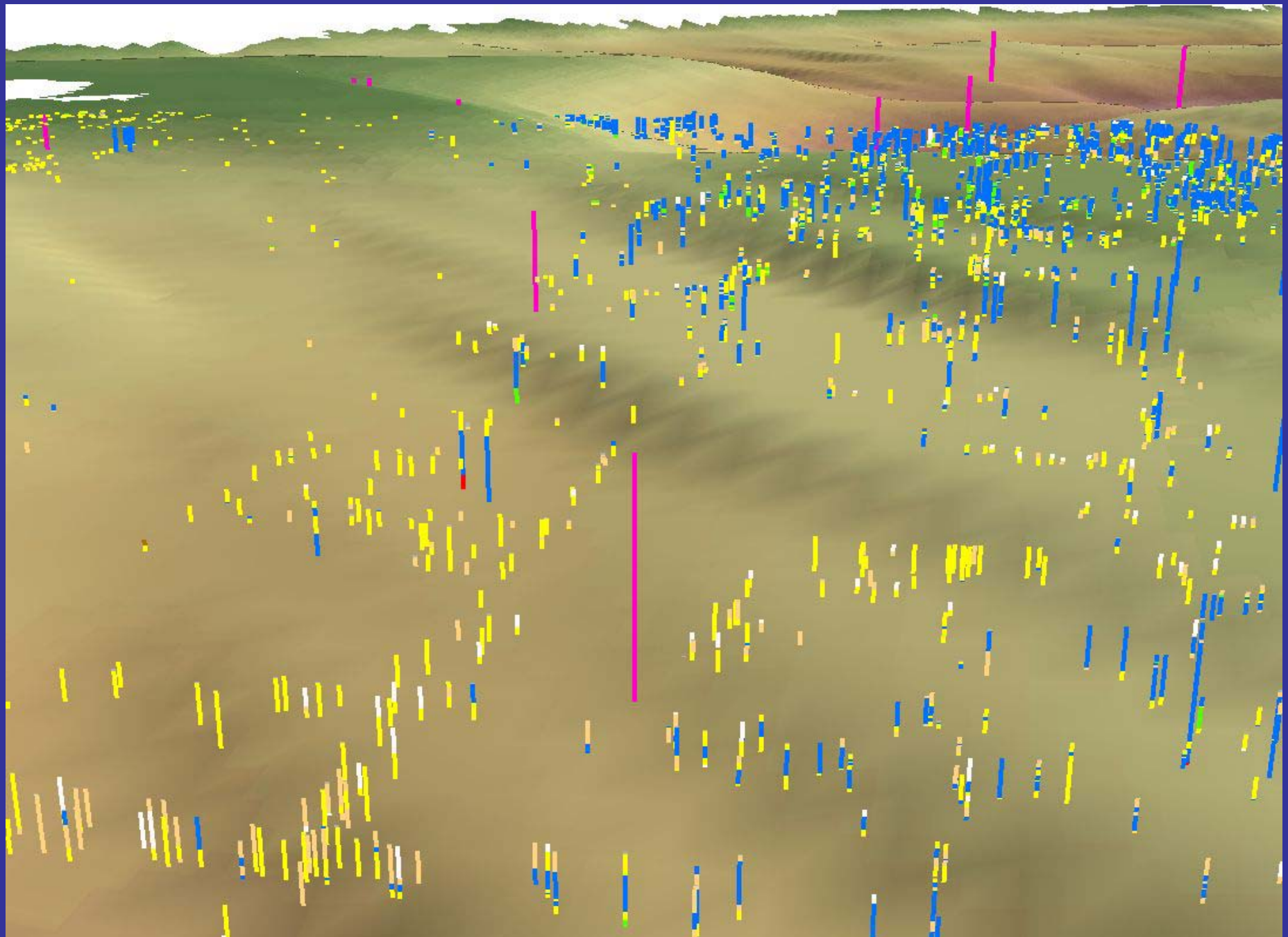
Screens: Yes ☒ No ☐
Manufacturer's Name Johnson
Type Stainless Steel Model No. .....
Diam. 6" Slot size 30 from 53 ft. to 63 ft.
Diam. ..... Slot size ..... from ..... ft. to ..... ft.

(10) **WELL LOG:**

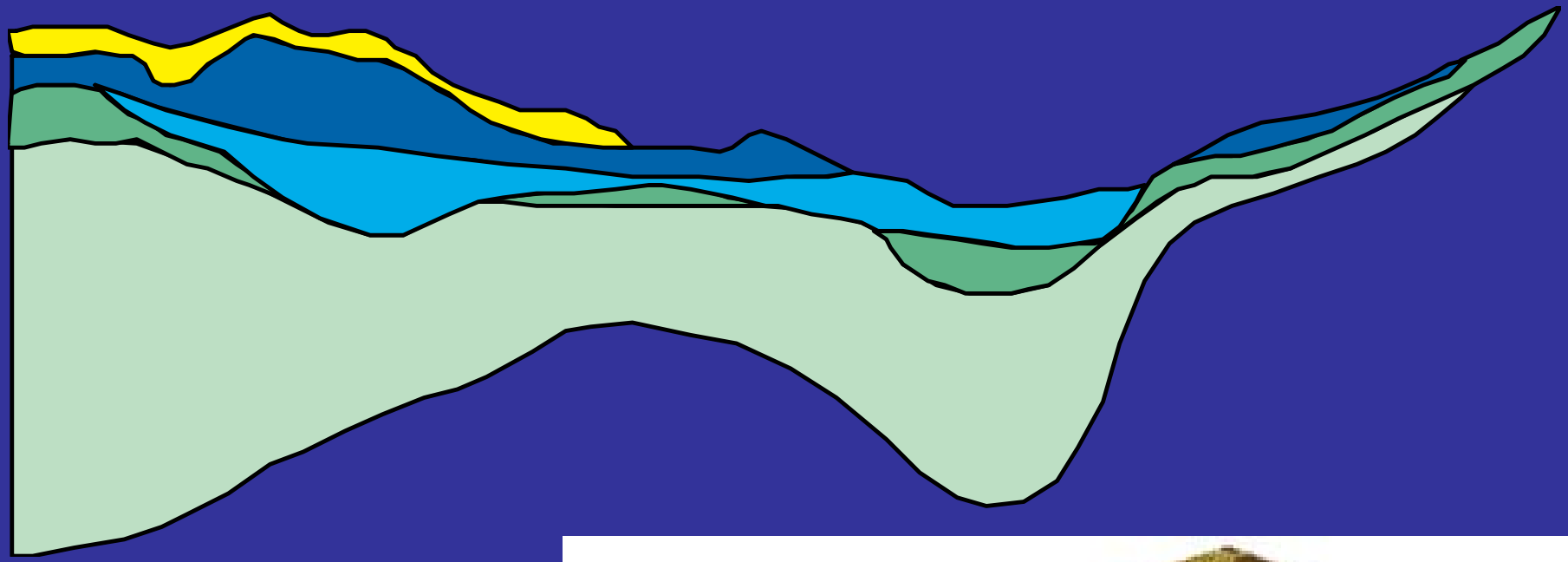
Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Topsoil	0	2
Brown small gravel	2	8
Brown clay and sand	8	12
Gray clay, some sand	12	18
Gray sand & some gravel, water	18	29
Brown clay	29	31
Gray clay	31	33
Gray sand and some gravel, water	33	37
Gray clay	37	53
Gray [redacted] sand & water, some gravel	53	63
Gray clay, some sand - lots of wood	63	68
Gray sand and some wood - water	68	83
Gray fine dirty sand - water	83	

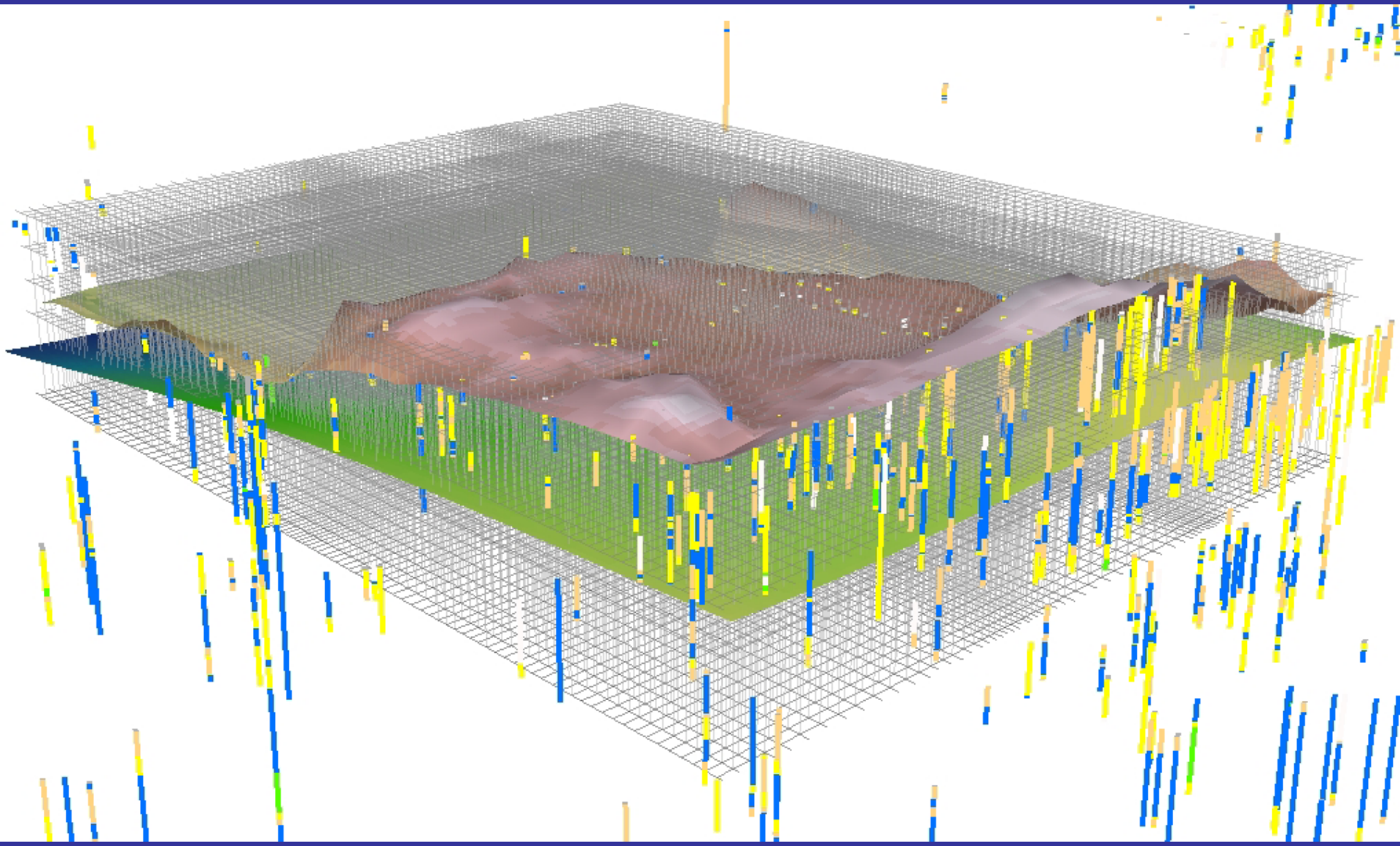
... to 3D database ...



... to hydrostratigraphic models ...



... to groundwater flow model

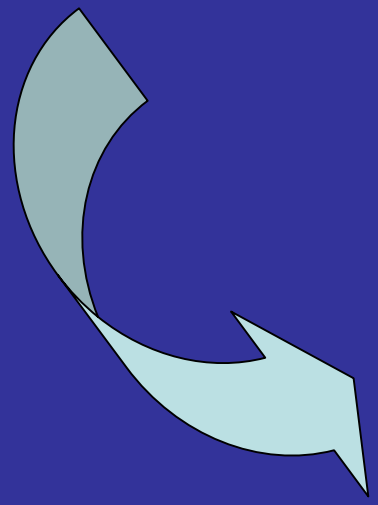


Canadian Database Data acquisition

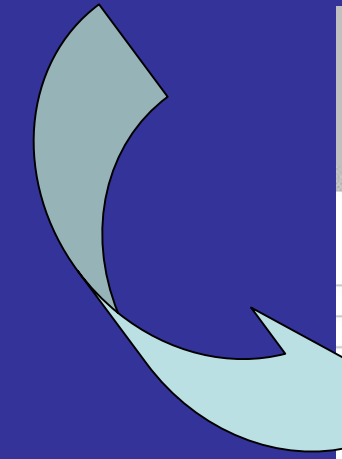
- drill well reports submitted to government (not mandatory)
- online well registration system free information but poor data quality
- lithology, location, well attributes

LITHOLOG STANDARDIZATION:

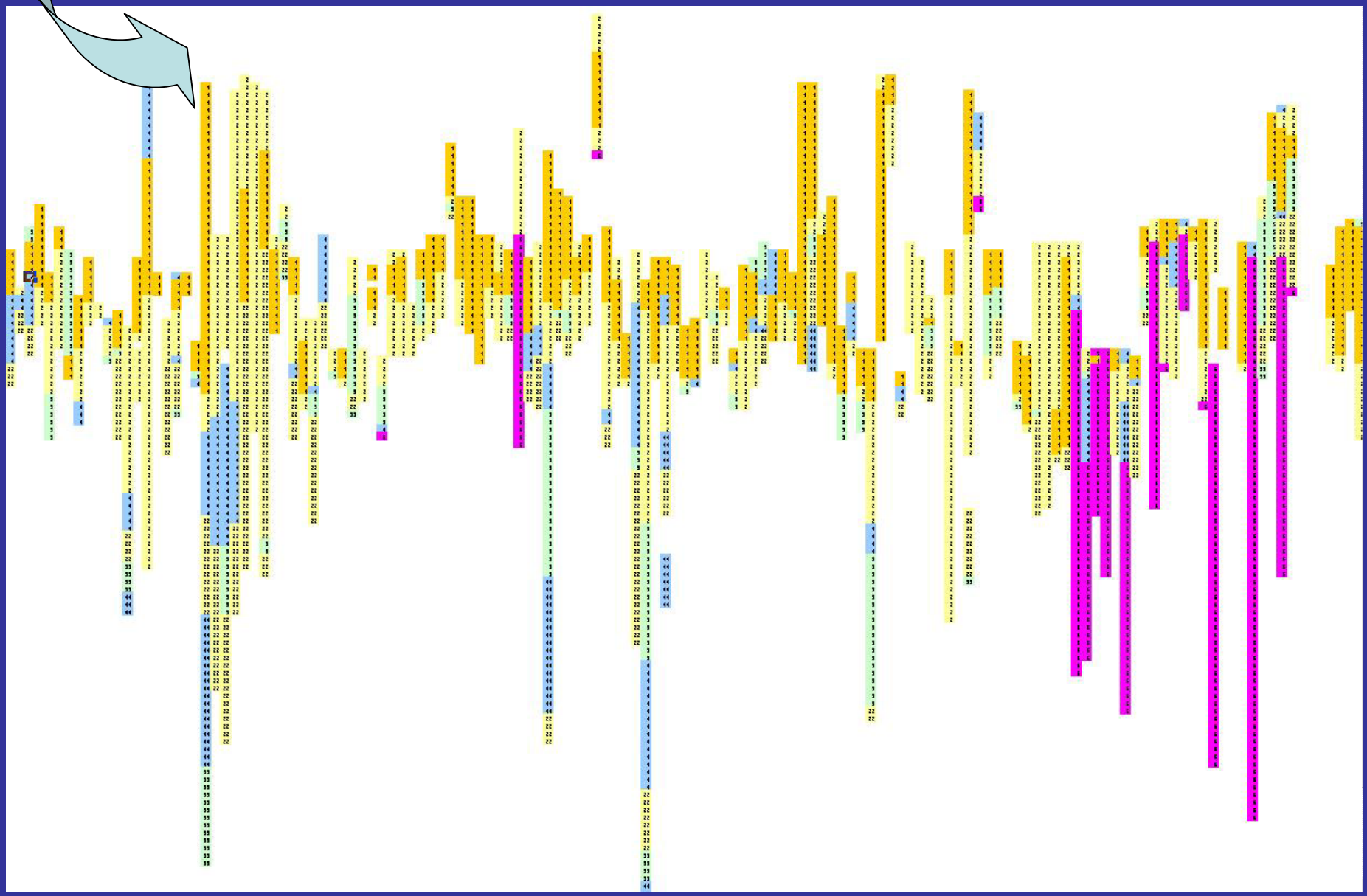
BCGS 082E008421 # 1 wtn 000000076552 UTM Zone 11 Easting Northing UTM Code From 6 To 7 Ft. BROKEN ROCK MOIST CLAY Seq# 2 Water Depth 3.4 Yield 30 Gallons per Hour (U.S./Imperial) Screen from to PT
BCGS 082E008421 # 1 wtn 000000076552 UTM Zone 11 Easting Northing UTM Code From 0 To 6 Ft. BROWN SAND & GRAVEL COBBLES Seq# 1 Water Depth 3.4 Yield 30 Gallons per Hour (U.S./Imperial) Screen from to PT



coarse gravel and silt
clean coarse sand and small w b gravel
very coarse sand/ coarse gravel and fine silt
coarse sand and med sand
med sand/ thin clay layers and some boulders
med and coarse sand/ fine sand and silt
coarse gravel with clay layers
coarse sand and some gravel
medium sand with pebbles
gravel/ some sand
very coarse gravel/ very little sand



[WTN]	[layer num]	[layer class]	[depth (top of layer)]	[depth (bottom of layer)]	[thickness]	**[material(1)]**	[modifier]	[size]	[color]	[structure]	**[material(2)]**	[modifier]	[size]	[color]	[structure]	**[material(3)]**	**[source text]**
5156	1		0	4	4	till											till
5156	2		4	30	26	cobbles					gravel						cobbles and gravels
5156	3		30	78	48	clay					silt				strips		clays and silt strips
5156	4		78	90	12	gravel		coarse			sand						coarse gravels and sands
5186	1		0	35.6	35.6												dug
5186	2		35.6	41	5.4	sand		coarse									coarse sand
5186	3		41	50	9	sand					clay						sand and clay
5186	4		50	55	5	sand											sand
5186	5		55	62	7	sand					gravel						sand and gravel (w b)
5186	6		62	63.6	1.6	sand		medium-coarse									med coarse sand
5280	1		0	8	8	silt											surface silts
5280	2		8	26	18	gravel		coarse									heavy gravels
5280	3		26	34	8	clay			brown								brown clay
5280	4		34	36.5	2.5	gravel											gravel
5280	5		36.5	60	23.5	clay					silt						clay and varied silts
5280	6		60	83	23	gravel		medium			sand	fine					medium gravels with fine sands
7863	1		0	55	55	gravel					sand	dry					gravel sand - dry
7863	2		55	76	21	sand					gravel	some					sand - some gravel - water - bearing
7863	3		76	78	2	sand			grey		clay						gray sand with clay
7869	1		0	5	5	soil					sand						topsoil - sand
7869	2		5	7	2	sand					gravel						sand/ gravel
7869	3		7	23	16	sand					gravel					cobbles	sand/ gravel/ cobbles
7869	4		23	44	21	sand					silt				in sand		silty sand
7869	5		44	59	15	sand	dirty										sand dirty
7869	6		59	66	7	sand					gravel						sand/ gravel
7869	7		66	81	15	sand		fine			silt				in sand		sand fine & silty
7869	8		81	91	10	silt											silt
7869	9		91	104	13	sand	clean	medium									medium sand clean
7869	10		104	115	11	silt											silt
7887	1		0	4	4	soil					gravel						top soil with gravel
7887	2		4	12	8	gravel					cobbles						gravel & cobbles
7887	3		12	17	5	sand					gravel						sand & gravel
7887	4		17	33	16	sand		medium fine			gravel						medium & fine sands with gravel
7887	5		33	37	4	sand	wet				gravel						moist sand & gravel
7887	6		37	70	33	sand					gravel					silt	water - bearing silty sand with gravel
7887	7		70	78	8	sand					gravel						cleaner sand with gravel/ water - bearing
7926	1		0	47	47	silt					cobbles				in silt		COBBLED SILTS
7926	2		47	66	19	silt	hardpan										HARDPAN



B.C. LITHOLOG STANDARDIZATION:

- raw data → **LDBuilder** → Access DB
- one record / litho unit in each litholog
- relational DB approach
- well ID & layer elevation as keys
- separate tables for lithology, location, attributes

B.C. LITHOLOG STANDARDIZATION:

Training standardization filter (time consuming):

- raw data has > 6000 unique sediment descriptions
- first pass produced >100 sediment categories
- review standards
- second pass produced 36 sediment categories
- treat bedrock (e.g. fractures) separately

DATABASE INTEGRATION CHALLENGES:

1) semantics in lithologs

- different level of detail

2) classification schemes

- digitize paper forms & scanned images (e.g. Dept Ecology)
- different well ID's

3) scale of the study area

DATABASE INTEGRATION CHALLENGES:

Schematic differences:

- 3 tables in Canadian DB: Lithology, General (address), UTM
- 4 tables in US DBs: Recovery, Material (lithology), Test (hydraulic), WellData (address)

Database structure:

- Canadian DB geology one field, US db. 3 fields (3 materials)
- different field names for same attributes (difficult to decipher metadata)

Semantic difference:

- Canadian db. standard 36 categories
- US db. 21 descriptors in 3 different fields (180 unique categories when 2 fields combined)
- reduced US db. to 36 categories prior to integration with Canadian db.

DATA QUALITY PROBLEMS:

Location:

- coordinates not available for many wells
- coordinates and elevation inaccurate
- get some coordinates from well address and Street Network files

Geology lithologs

- text file output not formatted correctly
- max 24 layers per litholog
- ground elevation often recorded as 0
- missing uppermost unit
- conversion of depths to elevations

DATA QUALITY PROBLEMS:

Quality depends on:

- driller's education and experience
- amount of detail reported to government database
- transcription errors
- type of sediments, method of drilling ...

"cryptic" litholog example:

Water bearing sand and gravel S/L 53'
Up to here look at Mr. _____'s room'
Whatcom
Stoney Clay

LAYERED HYDROSTRATIGRAPHY:

1) create cross-sections from standardized lithologs

2) generalize layers

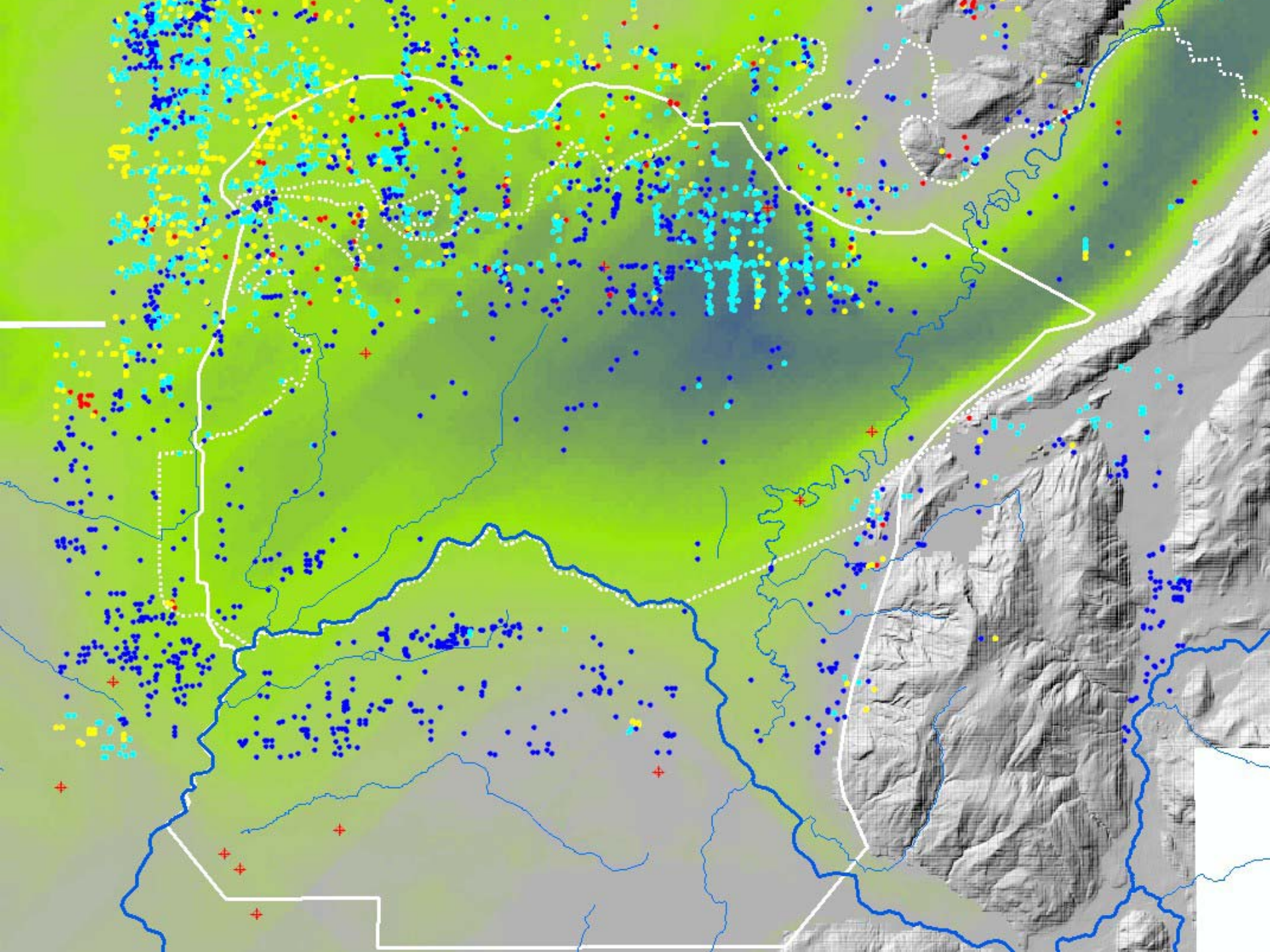
3) digitize layer boundaries and construct surfaces

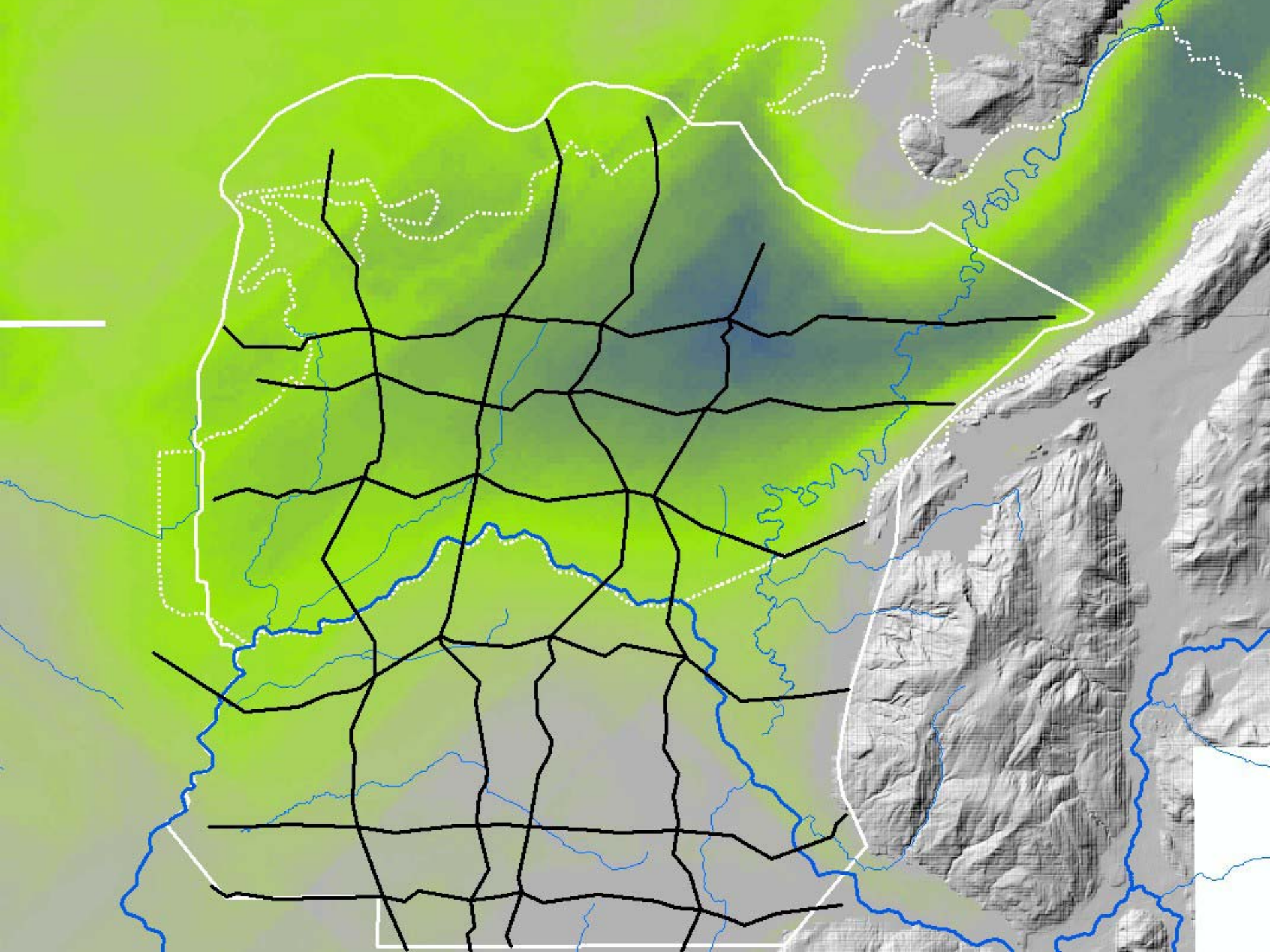
4) tie surfaces to valley walls

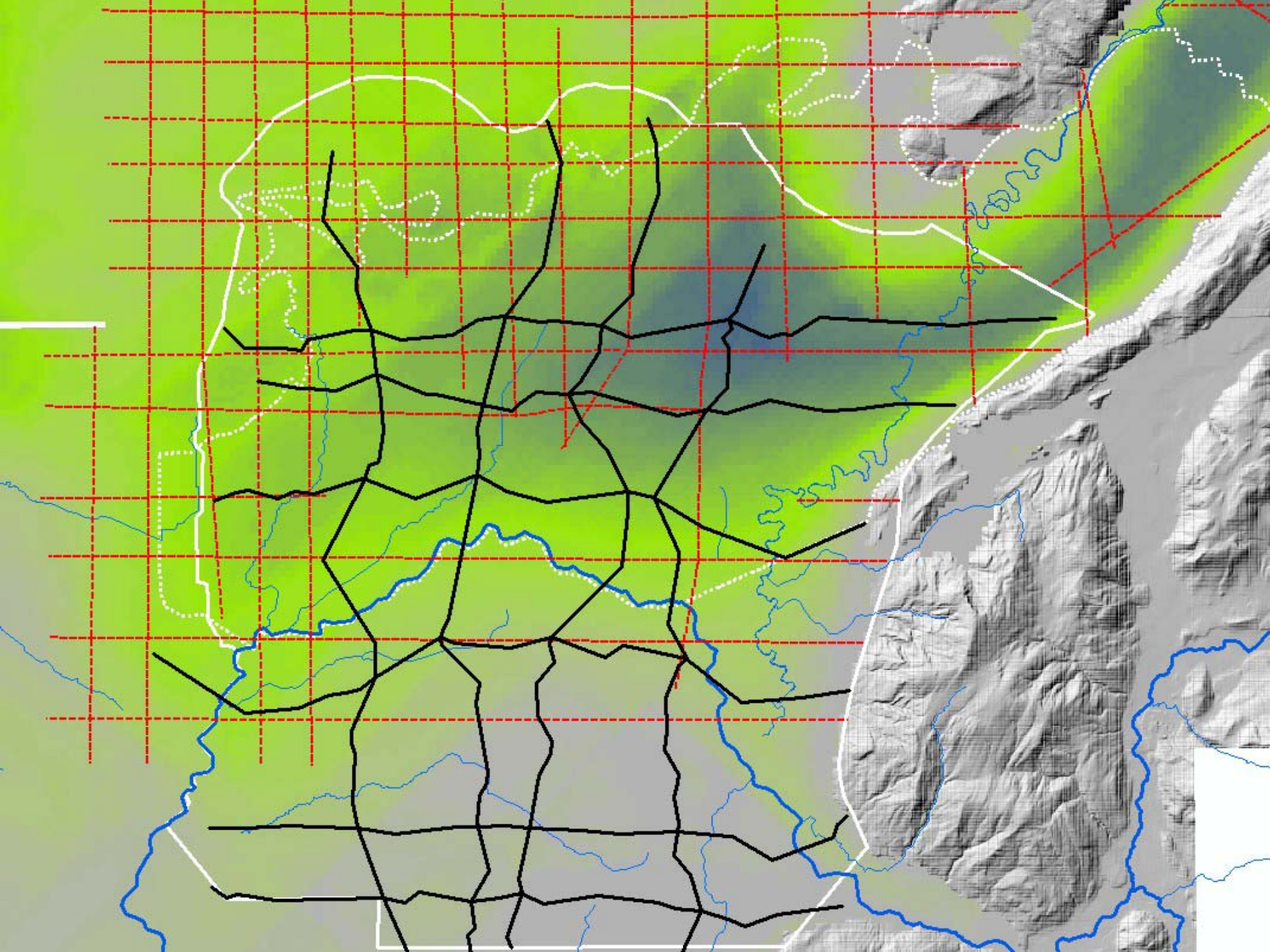
LAYERED HYDROSTRATIGRAPHY:

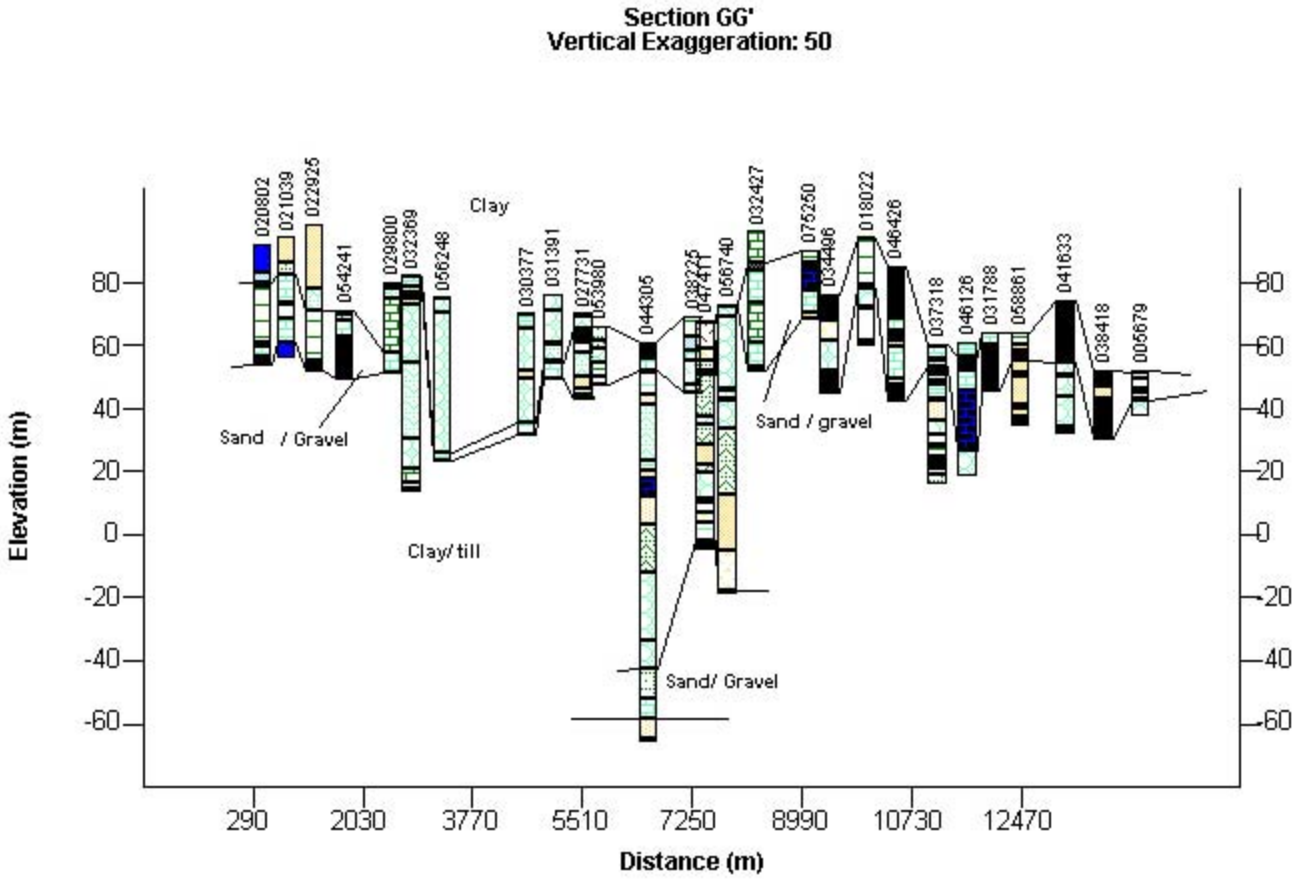
Problems:

- heterogeneity of glacial deposits
- correlation of lithologies
- lack of deep boreholes
- large GIS workload – time costs









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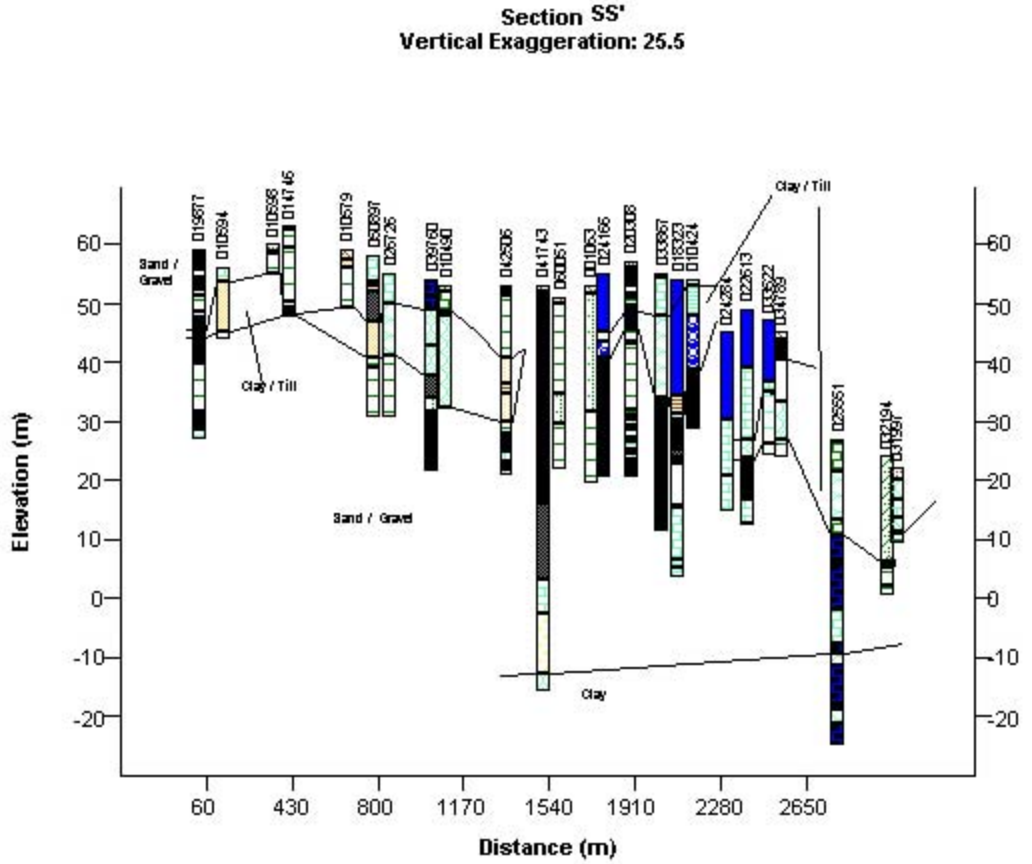
Dept. of Geography
Simon Fraser University
Burnaby
Canada

Geology Architecture Mapping Of the Abbotsford-Sumas Aquifer

Cross Section GG'



Interpretation Line

Line

Bore Hole

- Sand
- Sand & Gravel
- Clay
- Clay & Boulders
- Clay & Gravel
- Gravel
- Overburden
- Till
- Region
- Sand & Clay
- Clay & Silt
- Silt
- Gravel & Boulders
- Region
- Gravel & Silt
- Clay & Sand
- Gravel & Clay
- Till & Sand
- Silt & Sand
- Unknown
- Till & Clay

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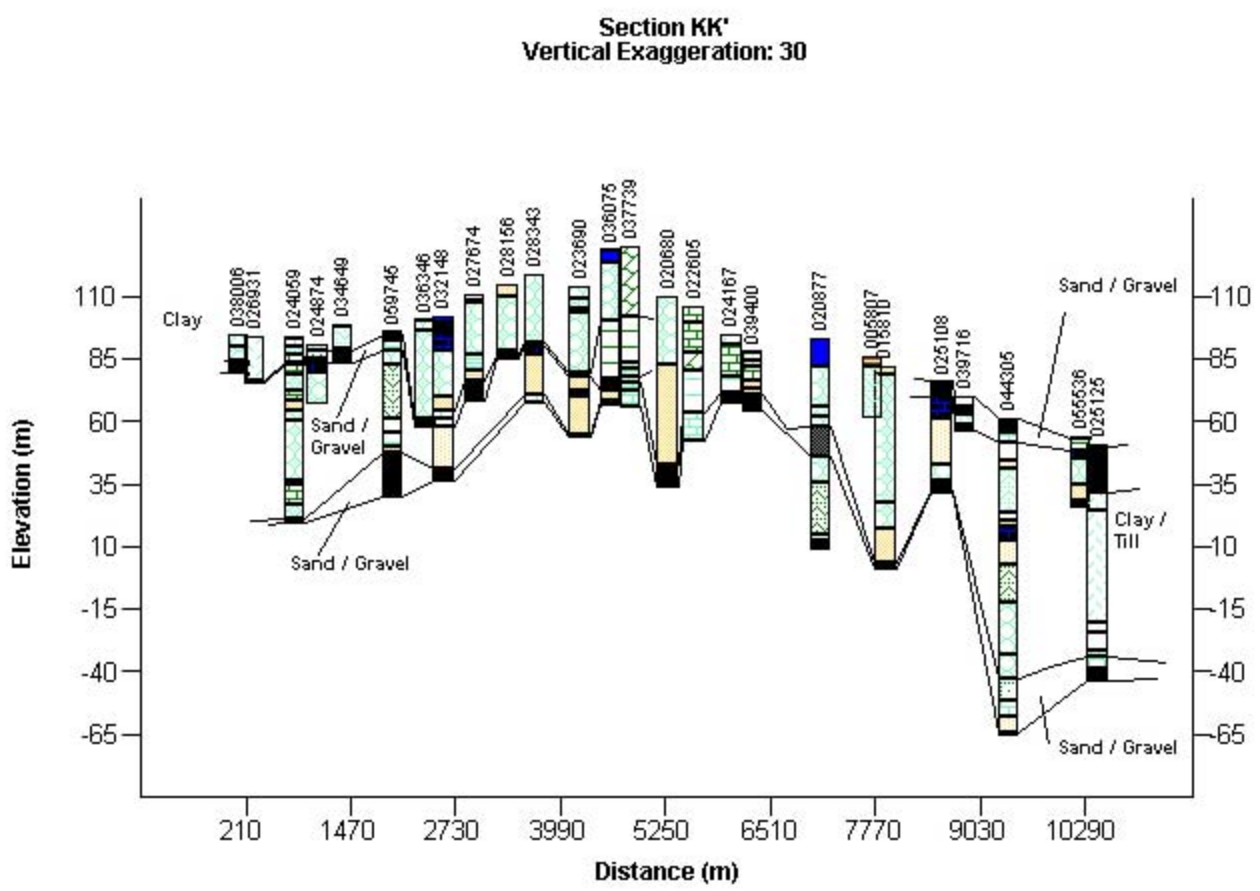
No Window

Geology Architecture Mapping of the Abbotsford-Sumas Aquifer

Cross Section SS'



Interpretation Line

Line

Bore Hole

- Clay
- Till
- Sand & Gravel
- Sand
- Clay & Gravel
- Gravel
- Overburden
- Clay & Sand
- Stoney Clay
- Unknown
- Silt
- Gravel & Silt
- Sand & Clay
- Till & Clay
- Clay & Silt
- Till & Sand
- Silt & Boulders
- Gravel & Boulders
- Boulders
- Till & Gravel
- Clay & Boulders
- Sand & Silt

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Simon Fraser University
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Canada

Geology Architecture Mapping of the Abbotsford-Sumas Aquifer

Cross Section KK'